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Characterisation of a Surface-Flashover Ion Source with 10-250 ns Pulse Width

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ENGINEERING

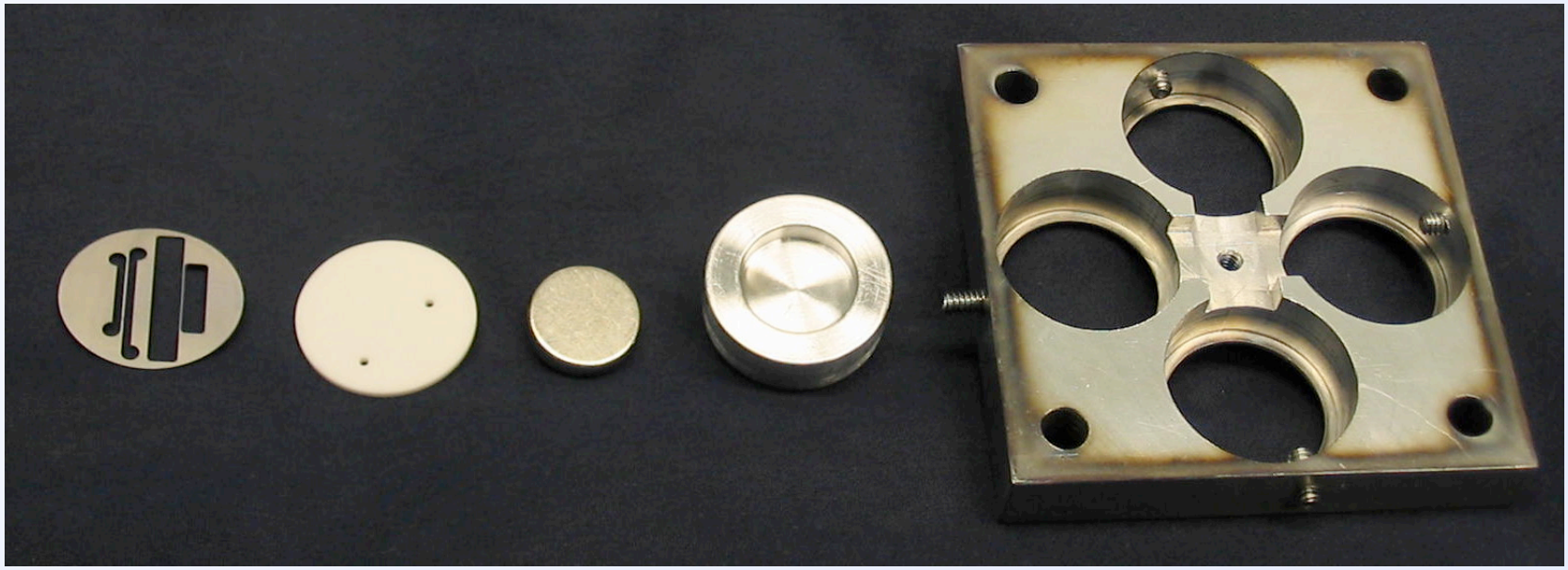
Submitted Abstract

- As a step towards developing an ultra compact D-D neutron source for various defense and homeland security applications, a compact ion source is needed. Towards that end, we are testing a pulsed, surface flashover source, with deuterated titanium films deposited on alumina substrates as the electrodes. As the duration of the arc current is varied, it was observed that the integrated deuteron current per pulse initially increases rapidly, then reaches a maximum near a pulse length of 100 ns. Thin film patterning techniques and deuteration parameters will be discussed.

- Keywords: deuterium ion source, surface flashover, arc, PACS 29.25.Ni

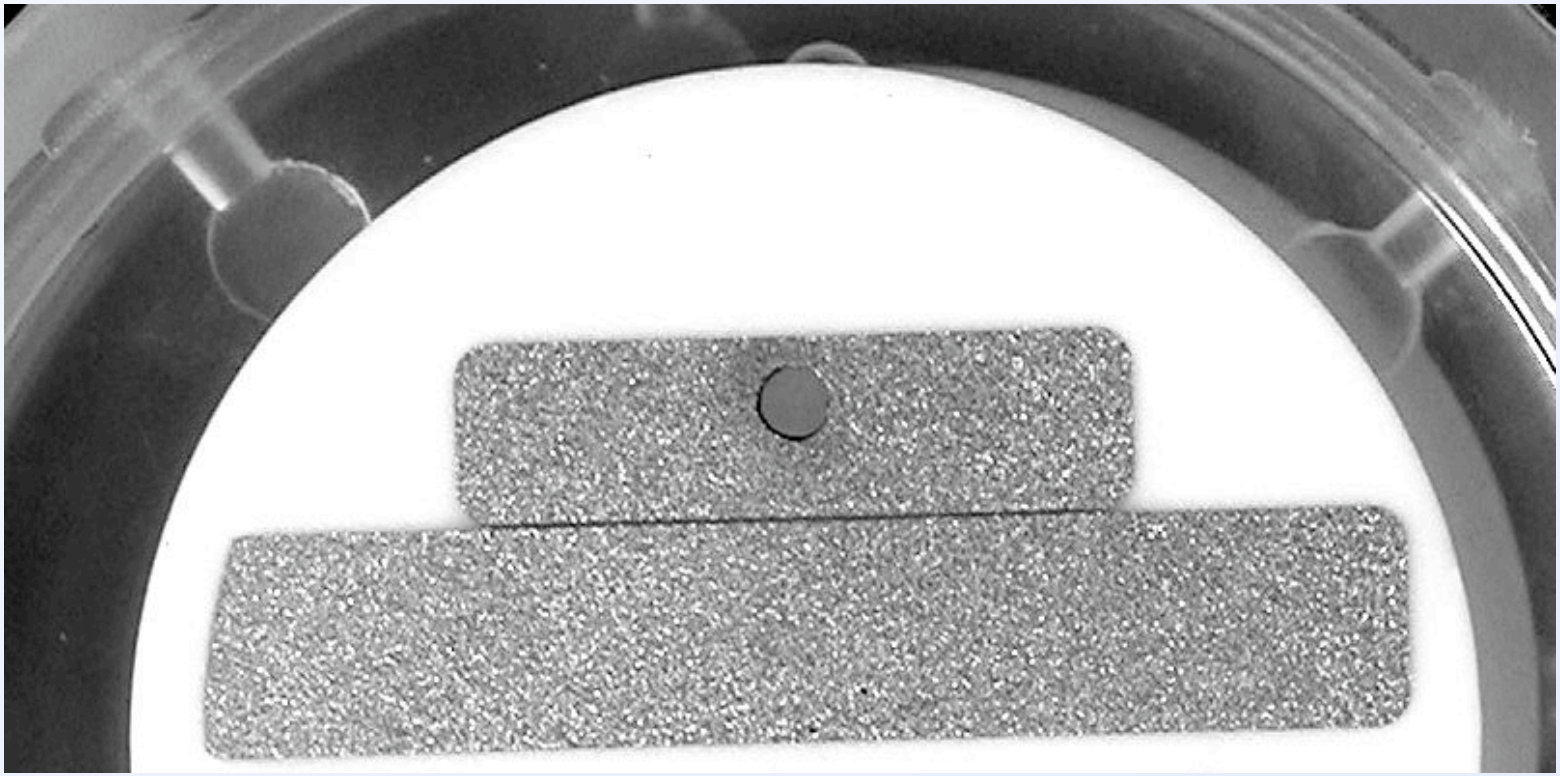
Surface-Flashover Ion Source Fabrication

- Source electrodes are vapor-deposited on an alumina disk through a shadow mask. A small magnet holds the mask tightly to the substrate during coating.



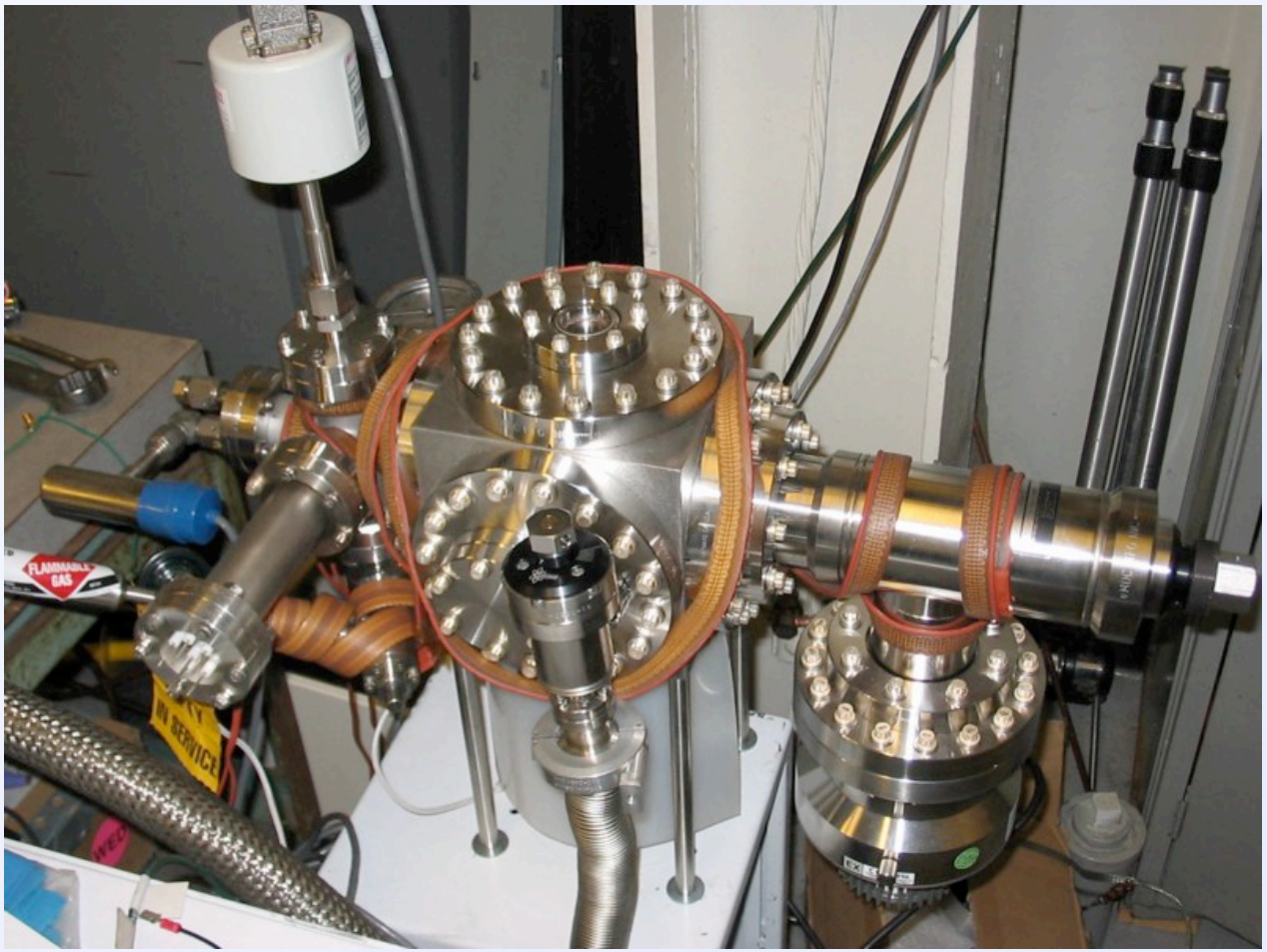
Completed Source

- 2 cm dia. alumina substrate with 1 μm thick Ti electrodes. The hole is for attaching the HV pulser connection. The gap is 0.127 mm (5 mils).



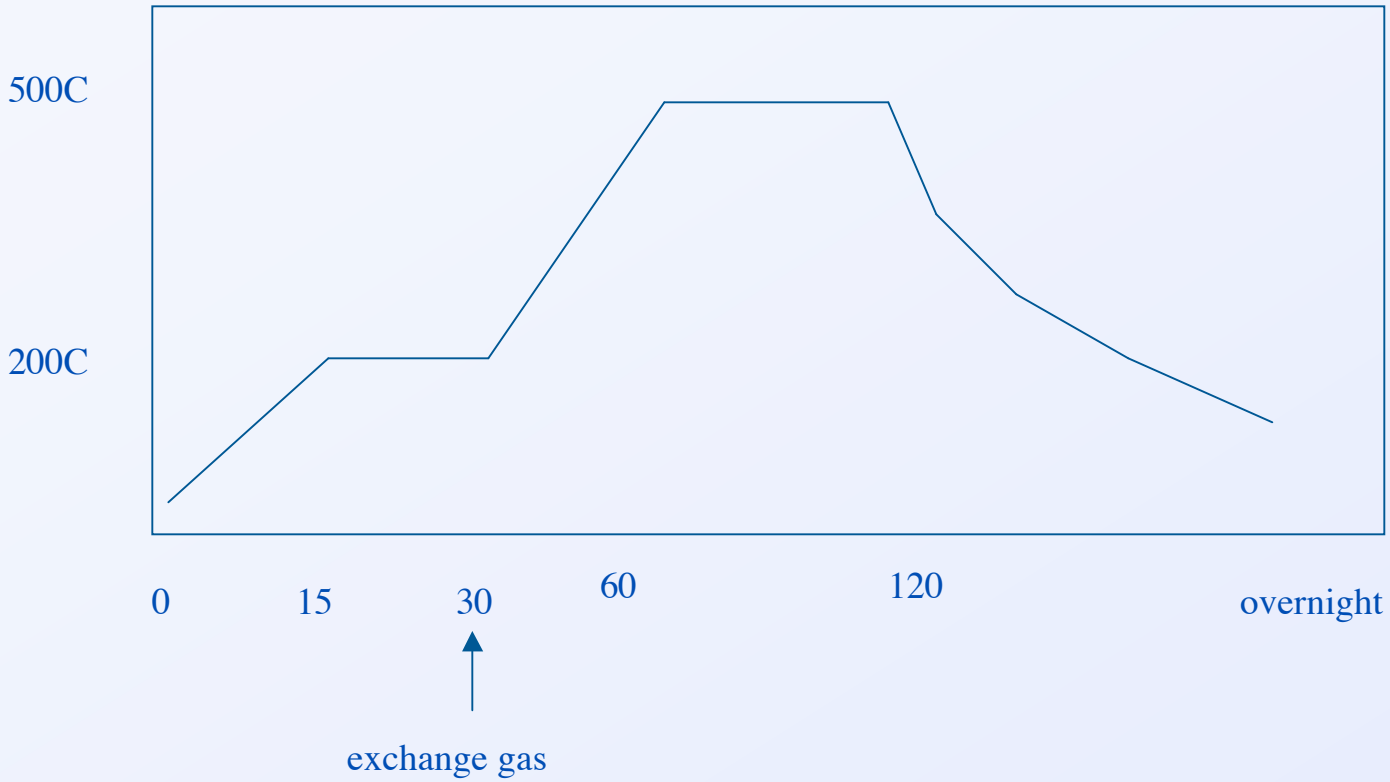
Deuterium Loading Chamber

- All metal-sealed, turbo-pumped system. Built specifically for this task. Substrate temperature was ~500 C. during loading.



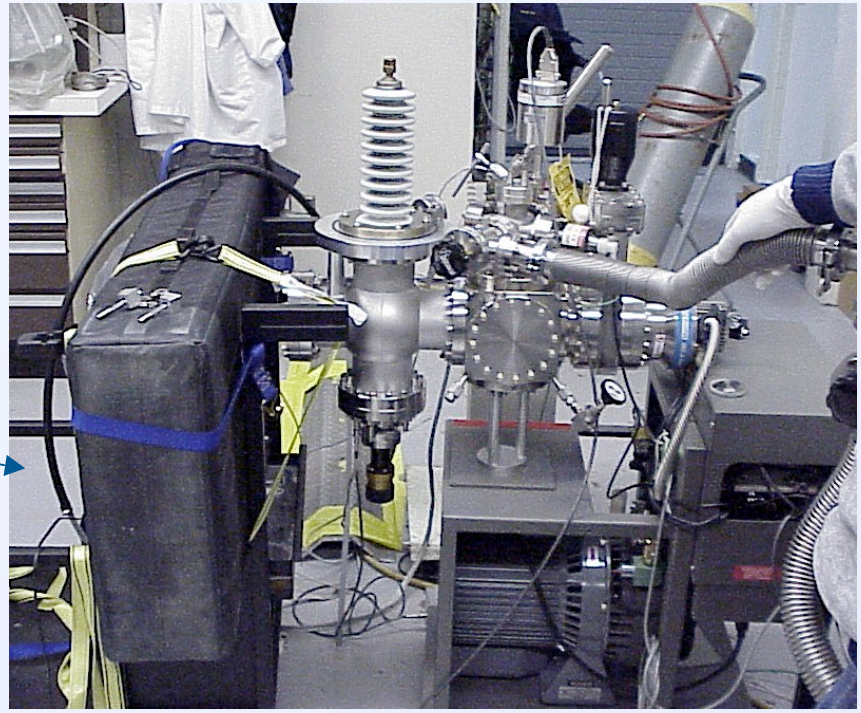
Deuterium loading parameters

- Started with 5 Torr backfill of D2, raised to 10 Torr for high temperature soak.



Ion Source Test Chamber

- HV supplied by 100kV DC supply
- Pulse to drive source provided by custom inductive adder. It can provide up to 10 kV and 1 μsec pulses.

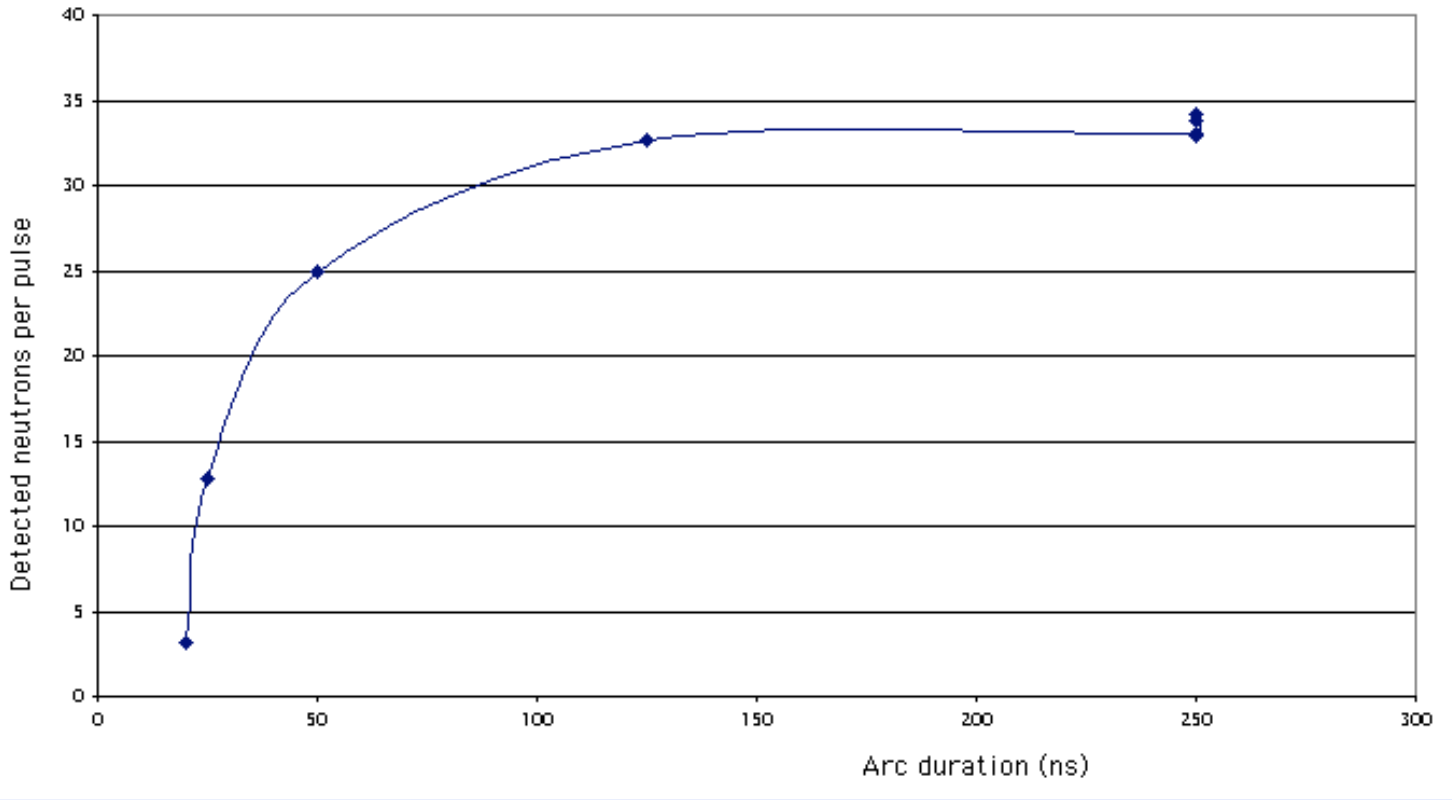


Ion current measured using D-D neutron yield

- ErD2 target placed at -90 kV at top of chamber.
- Source placed 90 mm below.
- Only D+ will produce measurable neutron yield at this voltage. Effectively discriminates against D2+ and other species.
- Neutron detector only records D-D fusion neutrons (no gammas)

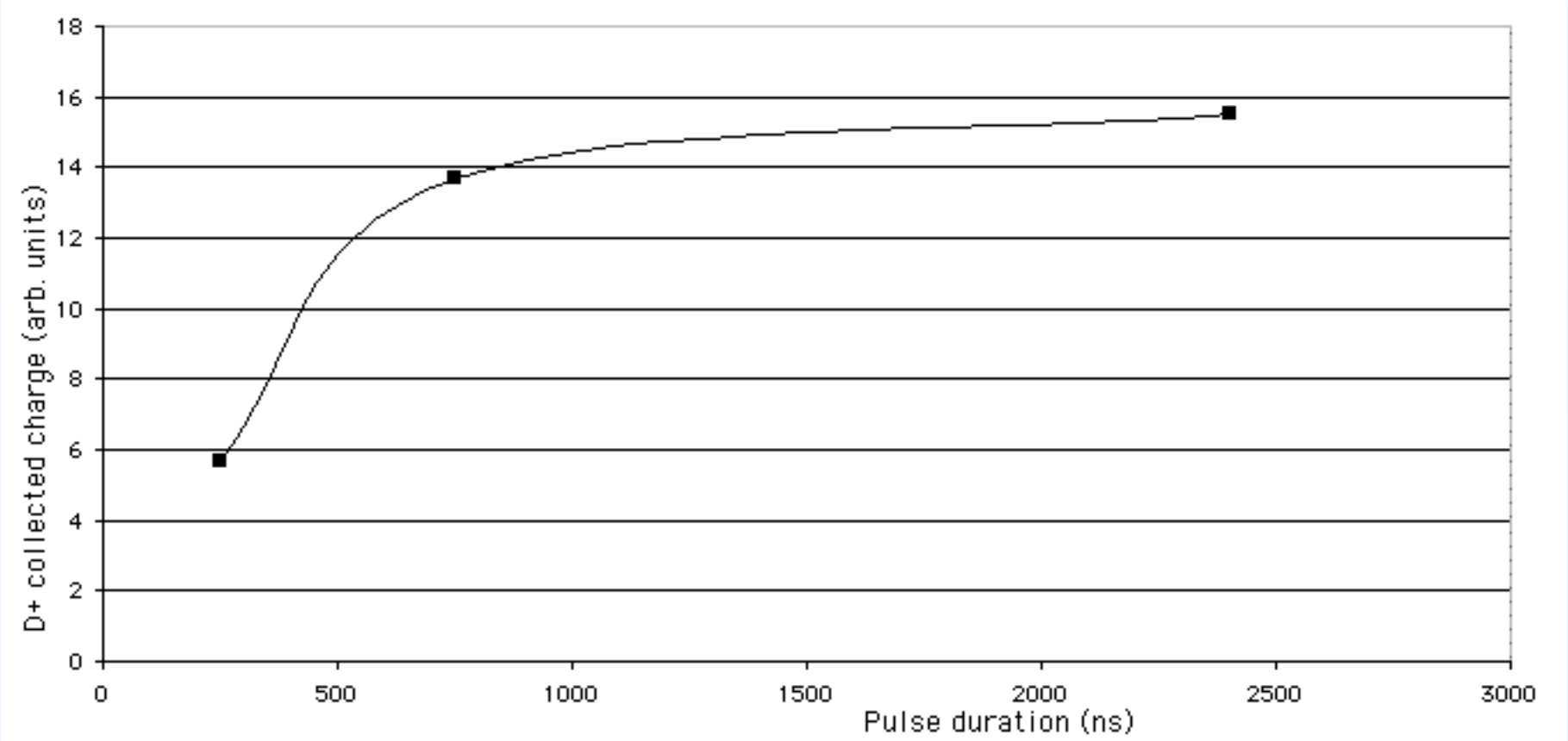
Neutron yield (proportional to D+ current)

- Yield saturates ~100 ns pulse width.



Saturation seen by Ref. 1 as well (but longer pulse width)

- D+ yield, measured using a TOF mass spectrometer.



Summary

- Production of ions from a surface flashover source show a saturation with increasing drive pulse width.
- Depletion of the interstitial gas from the arc site likely explanation.
- Higher arc currents can produce more ions, but can limit source lifetime.

references

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- 3) Cook, E.G.; Lee, B.S.; Hawkins, S.A.; Anaya, E.M.; Allen, F.V.; Hickman, B.C.; Sullivan, J.S.; Brooksby, C.A., "Solid-state kicker pulser for DARHT-2," Pulsed Power Plasma Science, 2001. PPPS-2001. Digest of Technical Papers , vol.1, no., pp. 632-635 vol.1, 2001